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Continued on last page

(54) [Title] PROJECTION APPARATUS

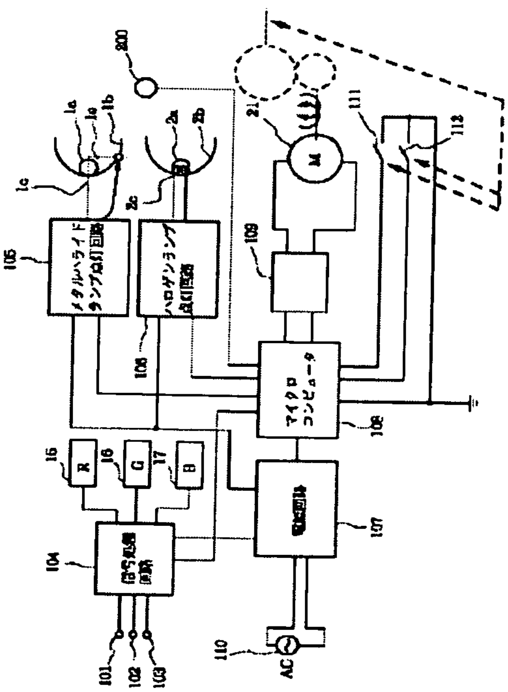
(57) Abstract

Objective

To realize a suitable projection apparatus using a plurality of light sources.

Means to solve

In a projection device using a plurality of light sources, the light source that provides the main illumination to a light valve is switched by moving the relative positions of the light sources and the mirrors that guide their emitted light to the light valve. Also, the configuration is simplified by using a common focusing device for the light sources.



Key: 104 Signal processing circuit

PU030306

105	Metal halide lamp lighting circuit
106	Halogen lamp lighting circuit
107	Power supply circuit
108	Microcomputer

Claims

1. Projection apparatus that has a light valve and modulates light by a plurality of pixels arranged two-dimensionally in said light valve and projects the modulated light, characterized by

a first light source,

a second light source,

a mirror that guides the light emitted from said first light source or the light emitted from said second light source to said light valve, and

a movable mechanism that can change the relative positions of said mirror and said first light source and second light source.

2. Projection apparatus that has a light valve and modulates light by a plurality of pixels arranged two-dimensionally in said light valve and projects the modulated light, characterized by

a first light source,

a second light source, and

a mirror that guides the light emitted from said first light source or the light emitted from said second light source to said light valve, and

the position of said mirror is changed either to irradiate the light emitted from said first light source to said light valve or to irradiate the light emitted from said second light source to said light valve.

3. Projection apparatus that has a light valve and modulates light by a plurality of pixels arranged two-dimensionally in said light valve and projects the modulated light, characterized

a first light source,

a second light source, and

a mirror that guides the light emitted from said first light source or the light emitted from said second light source to said light valve, and

the position of said first light source and/or second light source with respect to said mirror is changed either to irradiate the light emitted from said first light source to said light valve or to irradiate the light emitted from said second light source to said light valve.

4. Projection apparatus that has a light valve and modulates light by a plurality of pixels arranged two-dimensionally in said light valve and projects the modulated light, characterized by

a first light source,

a second light source, and

a reflecting mirror that focuses the light emitted from said first light source and the light emitted from said second light source, and

said first and second light sources are provided near the focal point of said reflecting mirror.

5. Projection apparatus described in Claim 4, having a light adjusting means that adjusts the quantity of light irradiated from said first light source to said light valve.

6. Projection apparatus described in Claim 4 or 5, wherein the quantity of light irradiated from said first light source to said light valve is gradually reduced until the second light source achieves stable operation after the second light source is turned on.

7. Projection apparatus described in any of Claims 4-6, having a control part that controls the quantity of emitted light close to a constant level by combining the quantity of light irradiated from said first light source to said light valve and the quantity of light irradiated from said second light source to said light valve.

8. Projection apparatus described in Claim 5, wherein said light adjusting means adjusts the quantity of light corresponding to correction data determined based on the variation in the quantity of light over time after said second light source starts to emit light.

9. Projection apparatus described in Claim 5, wherein said light adjusting means adjusts the quantity of light based on the result of determining the quantity of light illuminating said light valve.

10. Projection apparatus described in any of Claims 1-4, wherein the period from the activation of said first light source to the time of its stable operation is shorter than that of said second light source.

11. Projection apparatus described in any of Claims 1-10, having a timer used for controlling the irradiation of said light valve by the light emitted from said first light source.

12. Projection apparatus described in any of Claims 1-10, having a light quantity sensor used for controlling the irradiation of said light valve by the light emitted from said first light source.

13. Projection apparatus described in any of Claims 1-10, having a sensor that detects the quantity of light emitted from said second light source.

14. Projection apparatus described in any of Claims 1-13, having a stop means that stops the light emission of the second light source for a prescribed period of time.

15. Projection apparatus described in any of Claims 1-14, wherein said first light source is a xenon-type lamp, halogen lamp, tungsten-type lamp, fluorescent lamp, light-emitting diode, or electron-source-type light source.

16. Projection apparatus described in any of Claims 1-15, wherein said second light source is a metal halide lamp or a mercury-sealed-type discharge lamp.

17. Projection apparatus described in any of Claims 1-16, having an optical filter used in the period when said light valve is mainly illuminated by said first light source or the period when said light valve is mainly illuminated by said second light source to filter the light irradiated to said light valve.

18. Projection apparatus described in any of Claims 1-16, having a circuit that varies the video signal processing used for driving said light valve during the period when said light valve is mainly illuminated by said first light source and the period when said light valve is mainly illuminated by said second light source.

Detailed explanation of the invention

[0001]

Technical field of the invention

The present invention pertains to a light valve projection apparatus that magnifies and projects the images of liquid crystal panels or micromirror oscillating pixel panels. In particular, the present invention pertains to a projection apparatus having a light source of the instantaneous light emission type and a light source having high efficiency and a high color rendering index. The present invention is applicable to front projectors that project on transmissive screens or direct reflection type screens using a reflective liquid crystal device or micromirror oscillating pixels, or to rear projectors that project on transmissive screens, or to any apparatus that combines any of the aforementioned projectors with other machines.

[0002]

Prior art

Conventionally, an apparatus that magnifies and projects the image of a light valve panel with the aid of a liquid crystal device or the like by using a metal halide lamp or a different light source has been put into practical application. In this apparatus, the light emitted from the light source is focused on the light valve panel via a mirror or the like, and an image is displayed on a screen through a projection lens. Liquid crystal panels include single-panel types that use one liquid crystal panel and three-panel types that use three liquid crystal panels and perform color separation and color synthesis by dichroic mirrors or the like. Along with transmissive liquid crystal panels, reflective liquid crystal panels have also been put into practical application in recent years. There is another type of panel, which does not use liquid crystal devices but arranges micromirrors as pixels on a semiconductor chip and oscillates the mirror of each pixel to control the gradation. This type of panel is also known to include single-panel types using color sequential light sources and three-panel types that use three panels and perform color separation and color synthesis by dichroic mirrors or the like.

[0003]

Also, the illumination being used is required to have high luminance in order to produce a visible projected image on a large screen even in a bright room. Metal halide lamps, high-pressure mercury lamps, and the like with high efficiency and a high color rendering index have become the most popular light sources in recent years.

[0004]

Figure 11 shows an example of the configuration of a conventional 3-panel liquid crystal projector. In Figure 11, 1a represents a metal halide lamp, which is a discharge tube, 1b represents a reflecting mirror formed into an elliptical surface or paraboloid, 1c represents the electrode of metal halide lamp 1a, 5 represents a first fly's-eye lens, 6 represents a reflecting mirror, 7 represents a second fly's-eye lens, 8, 9 represent dichroic mirrors, 10, 11, 12 represent mirrors, 13 represents a cross dichroic prism, 14 represents a projection lens, 15 represents a red transmissive liquid crystal panel, 16 represents a green transmissive liquid crystal panel, 17 represents a blue transmissive liquid crystal panel, 18 represents an optical system light shield case, and 100 represents a housing that accommodates the entire projection system.

[0005]

When the power switch of the apparatus shown in Figure 11 is turned on, metal halide lamp 1a is turned on. Then, the light emitted from metal halide lamp 1a is converted into relatively parallel illuminating light by reflecting mirror 1b and is incident on fly's-eye lens 5. Fly's-eye lens 5 is comprised of a plurality of lenses and can make the luminance more uniform on the irradiated surface in the next stage when it is used in combination with fly's-eye lens 7.

[0006]

6 represents a reflecting mirror, which bends the optical path of the illuminating light emitted from fly's-eye lens 5 by 90° and irradiates it to fly's-eye lens 7. Mirror 6 has a dichroic film configuration that passes infrared light and ultraviolet light to reduce the infrared light and ultraviolet light in the chromatic light incident on fly's-eye lens 7 in order to alleviate heating and to improve reliability. The chromatic light exiting from fly's-eye lens 7 is incident on dichroic mirror 8. Blue light is transmitted on the optical path bent by mirror 10 to illuminate blue transmissive liquid crystal panel 17.

[0007]

On the other hand, the green and red light with longer wavelengths than the blue light are reflected by dichroic mirror 8 and are incident on dichroic mirror 9. Dichroic mirror 9 can reflect

the green light to illuminate green transmissive liquid crystal panel 16. Also, the red light with a longer wavelength than the green light is passed by dichromic mirror 8 [sic; 9] on the optical path shaped by mirrors 11 and 12 to illuminate red transmissive liquid crystal panel 15.

[0008]

The driving signals for the respective colors, although not shown in the figure, are input into said red transmissive liquid crystal panel 15, green transmissive liquid crystal panel 16, and blue transmissive liquid crystal panel 17 in order to display images in the display areas of the panels and to optically modulate said illuminating lights.

[0009]

In this case, the image displayed on said green liquid crystal panel 16 is inverted in the vertical direction (Figure 11 shows the top view) electrically or by reversing the front and back of the panel as opposed to the images displayed on said liquid crystal panels 15, 17 of other colors in consideration of the image synthesis process by dichroic mirror 13.

[0010]

The image light from red transmissive liquid crystal panel 15, green transmissive liquid crystal panel 16, and blue transmissive liquid crystal panel 17 is incident from predetermined directions as shown in the figure on cross dichroic prism 13. The image light is synthesized to form a color image. The light exits from the fourth side shown in the figure to projection lens 14 and is magnified and projected by projection lens 14. The configuration using two light sources is disclosed in Japanese Kokai Utility Model Application No. Hei 4[1992]-33034 and Japanese Kokai Patent Application No. Hei 9[1997]-127467.

[0011]

Problems to be solve by the invention

The objective of the present invention is to realize a suitable configuration using a plurality of light sources in a projection apparatus.

[0012]

Means to solve the problems

If a metal halide lamp, high-pressure mercury lamp, or other discharge-type lamp with high efficiency and a high color rendering index is used as the light source in a liquid crystal or micromirror oscillating pixel type projection apparatus, it will take about 2-3 min or longer for the

quantity of light emitted from said illuminating light source to reach a prescribed level after the apparatus has been turned on.

[0013]

Also, a long time (3-5 min) is needed for recovery from any sudden loss of power before the light source can be turned on again. Since no image is displayed in that period, it is a serious problem for important presentations, meetings, or other urgent applications.

[0014]

In the aforementioned case, it is desired to provide a plurality of light sources that can illuminate the light valve. The present invention provides a configuration that can efficiently illuminate the light valve when a plurality of light sources is used and can simplify the configuration even when a plurality of light sources is used.

[0015]

One of the projection apparatuses disclosed in the present patent application has the following configuration. The projection apparatus has a light valve and modulates light by a plurality of pixels arranged two-dimensionally in said light valve and projects the modulated light. It is characterized by a first light source, a second light source, a mirror that guides the light emitted from said first light source or the light emitted from said second light source to said light valve, and a movable mechanism that can change the relative positions of said mirror and said first light source and second light source. Since this configuration has a movable mechanism that can change the relative positions of said mirror and light sources, it is possible to switch between the state in which the light valve is mainly illuminated by the first light source and the state in which the light valve is mainly illuminated by the second light source by changing the relative positions of the mirror and the light sources. Therefore, there is no need to provide a half-silvered mirror used for sharing part of the optical path of the light emitted from each light source with the optical paths of the output light from the separate light sources. In this way, the light can be used efficiently. To change the relative positions of the mirror and the light sources, it is desired to adopt a constitution that changes the position of the mirror or a constitution that changes the positions of the light sources.

[0016]

Another projection apparatuses disclosed in the present patent application has the following configuration. The projection apparatus that has a light valve and modulates light by a plurality of pixels arranged two-dimensionally in said light valve and projects the modulated light. It is

characterized by a first light source, a second light source, and a reflecting mirror that focuses the light emitted from the first light source and the light emitted from the second light source, and said first and second light sources are provided near the focal point of said reflecting mirror.

[0017]

In the present invention, the structure of the light source part can be extremely simplified. Preferably, a configuration can be used, in which said first and second light sources have different light emission characteristics (especially, the variation in quantity of light over time after the power is turned on). In the present invention, it is possible to adopt a configuration having a light adjusting means that adjusts the quantity of light irradiated by the first light source to the light valve. Preferably, a control circuit that can adjust the quantity of the output light of the first light source is used as said light adjusting means. Preferably, the quantity of light irradiated from said first light source to said light valve is gradually reduced until the second light source achieves stable operation after the second light source is turned on.

[0018]

The visual discomfort of the image can be alleviated by controlling the quantity of the emitted light close to a constant level by combining the quantity of light irradiated from said first light source to said light valve and the quantity of light irradiated from said second light source to said light valve. More specifically, the aforementioned control circuit that adjusts the quantity of the output light from the first light source can be used as this control part. It is also possible to adopt a configuration that adjusts the quantity of light corresponding to correction data determined based on the variation in the quantity of light over time after said second light source starts to emit light as the means for realizing said light adjustment. A timer can also be used to adjust the light over time. The aforementioned light adjustment can also be performed based on the result of determining the quantity of light illuminating said light valve.

[0019]

Each of the aforementioned inventions can be suitably applied to the case where two light sources have different characteristics. It is particularly suitable for the case when the period needed for the first light source to reach a stable lighting state after the power is turned on is shorter than that of the second light source. In this case, the period to reach the stable lighting state after the power is turned on refers to the period from the time when the power is turned on to the time when the quantity of light reaches 90% of the quantity of light emitted after a sufficiently long period has passed after the power is turned on (stable light emission). This is particularly suitable for the case

when the period for the first light source to reach the stable lighting state after the power is turned on is shorter than that of the second light source by 15 sec or longer.

[0020]

Each of the aforementioned inventions preferably uses a configuration having a timer used for controlling illumination of said light valve by the light emitted from said first light source or a configuration having a light quantity sensor used for controlling illumination of said light valve by the light emitted from said first light source. For example, it is possible to control the quantity of light illuminating the light valve by the first light source corresponding to the output value of the sensor that detects the quantity of the output light of the second light source. In each of the aforementioned inventions, it is preferred to have a stop means that can stop light emission of said second light source for a prescribed period of time. In this way, it is possible to stop the light emission of the second light source after the power is turned off. In this case, the light valve is illuminated by the light emitting from the first light source. Preferably, the first light source is a xenon-type lamp, halogen lamp, tungsten-type lamp, fluorescent lamp, light-emitting diode, or electron-source-type light source. Also, preferably, the second light source is a metal halide lamp or a mercury-sealed-type discharge lamp.

[0021]

In addition, preferably, each of the aforementioned inventions can adopt a configuration using an optical filter in the period when said light valve is mainly illuminated by said first light source or the period when said light valve is mainly illuminated by said second light source to filter the light irradiated to said light valve. Each of the aforementioned inventions can also adopt a configuration having a circuit that varies the computation with respect to the video signal used for driving said light valve during the period when said light valve is mainly illuminated by said first light source and the period when said light valve is mainly illuminated by said second light source. Examples of the computation with respect to said video signals include the computations for adjusting the contrast, brightness, or degamma property of the images.

[0022]

Embodiment of the invention

First application example

This application example discloses a projection apparatus having light sources and a projector that illuminates a light valve with the lights emitted from the light sources and projects the light on a screen by a projection lens. When this apparatus comprising a first light source that can be turned on instantaneously, a second light source with high efficiency and a high color

rendering index, a light source switching means, and a light source lighting sequence control means is turned on, the image is projected instantaneously by the light source with the faster lighting speed. When the light source with stable operation at high efficiency but with a slower lighting speed reaches the stable lighting state, the optical path is switched to that light source. At that time, the light source with the faster lighting speed is stopped. The latter light source can act as the illuminating light source to project images at high efficiency with a high color rendering index.

[0023]

Figure 1 can best show the characteristics of this application example. It is a top view illustrating the internal structure of the projection system in the projection apparatus disclosed in this application example. In Figure 1, 1a represents a metal halide lamp, which is a discharge tube acting as an illuminating means that needs a relatively long period (t = B) to reach the stable lighting state after the power is turned on. 1b represents a reflecting mirror formed into an elliptical surface or paraboloid. 1c represents the electrode of metal halide lamp 1a. 2a represents a halogen lamp acting as an illuminating means that needs a relatively long period (t = A) to reach the stable lighting state after the power is turned on. 2b represents a reflecting mirror formed into an elliptical surface or paraboloid. 2c represents the electrode of halogen lamp 2a. 3 represents a movable mirror. 4 represents a shutter. 5 represents a first fly's-eye lens. 6 represents a reflecting mirror. 7 represents a second fly's-eye lens. 8, 9 represent dichroic mirrors. 10, 11, 12 represent mirrors. 13 represents a dichroic prism. 14 represents a projection lens. 15 represents a red transmissive liquid crystal panel. 16 represents a green transmissive liquid crystal panel. 17 represents a blue transmissive liquid crystal panel.

[0024]

Also, 18 represents an optical system light shield mask. 19a represents a timing belt. 19b represents a coupling member that connects timing belt 19a with movable mirror 3. 19c represents a coupling member that connects timing belt 19a with shutter 4. 20a, 20b, 20c represent pulleys for driving the timing belt. 20d represents a pulley for running the gear-interactive timing belt. 20e represents a gear that interacts with pulley 20d and has a larger radius than pulley 20d. 20f represents a driving electric motor coupled coaxially with said gear 20e. 21 represents a driving motor connected coaxially with said gear 20f. 100 represents a housing that accommodates the entire projection system.

[0025]

Figure 4 is a diagram illustrating the electric configuration of this application example. In Figure 4, 101 represents a red signal input terminal; 102 represents a green signal input terminal;

103 represents a blue signal input terminal; 104 represents a signal processing circuit block; 105 represents a metal halide lamp lighting circuit; 106 represents a halogen lamp lighting circuit; 107 represents the entire power supply circuit; 108 represents a microcomputer acting as the apparatus control means for controlling this system; 109 represents a motor driving circuit; 21 represents an electric motor for driving timing belt 19a; 111, 112 represent switches acting as the position sensors for detecting the position of timing belt 19a or shutter 4 or mirror 3; and 110 represents the power supply terminal of the projection apparatus disclosed in this application example.

[0026]

Figure 5 shows the internal control flow chart when starting and stopping the projector. Figure 6 shows the internal flow chart when the power of the projector is cut off instantaneously.

[0027]

Figure 2 shows the structure of the metal halide lamp unit in the projection system disclosed in the application example shown in Figure 1. First, metal halide lamp 1a is fixed almost at the focal point of reflecting mirror 1b having an elliptical surface or paraboloid. The electrode 1c of metal halide lamp 1a extends through a small hole formed at the central position of the optical axis in the direction opposite the projection direction of reflecting mirror 1b.

[0028]

Although the other electrode is not shown in the figure, a metal wire 1e penetrates through the outer periphery of reflecting mirror 1b at a position that is relatively far away from the electrode 1c of said metal halide lamp 1a and is connected by an insulated cord to metal halide lamp lighting circuit 105 in said Figure 14.

[0029]

Figure 3 shows the structure of the halogen lamp unit in this application example. Halogen lamp 2a is fixed almost at the focal point of reflecting mirror 2b having an elliptical surface or paraboloid. Electrode 2c is guided to the rear through a relatively small through hole in the rear part of the optical axis of said reflecting mirror 2b and is connected by an insulated cord to halogen lamp lighting circuit 106 shown in Figure 14.

[0030]

In the following, the operation will be explained sequentially based on the sequence diagram shown in Figure 5 immediately after the operation switch is turned to the projection mode

(referred to as initial state hereinafter) from the state when the power of the projection apparatus disclosed in this application example is not on or from the standby state in which the power or the main power has been turned on.

[0031]

Also, although a detailed explanation of the figure is omitted, the temperature rise caused by heating of the light sources or the like in the main body is lowered to a safe temperature by using the cooling fan or the like in the main body. First, as shown in the sequence diagram in Figure 5, immediately after the power is turned on or the operation switch is turned to the projection mode from the standby state in which the main power has been turned on in step S1, the microcomputer is initialized (step S2), and said halogen lamp 2a is turned on (step S3). Similarly, metal halide lamp 1a is also turned on (step S5).

[0032]

The luminance rise characteristics immediately after said halogen lamp 2a and metal halide lamp 1a are turned on are as follows. Halogen lamp 2a reaches a sufficiently high luminance immediately after it is turned on (usually about 300 mSec, which is about 90% of the final luminance) and continues stable light emission after that. Consequently, halogen lamp 2a is used as the light source in step S4, and the signal processing circuit is started to display the image.

[0033]

For metal halide lamp 1a, however, the quantity of light gradually increases. About 20 sec after lighting, the mercury vapor pressure inside the lamp starts to rise. The lamp voltage rises sharply and reaches a level close to the rated voltage after 2-3 min. The time for the lamp to reach the stable state varies due to influences such as the external forced air cooling state during the rise of the lamp voltage and the presence/absence of reflectors or glass on the front surface of the lamp.

[0034]

The current is controlled while observing the period for the lamp to reach the stable state and the lamp voltage by lighting circuit 105. Consequently, the increase of the quantity of light is almost congruent with the behavior of the lamp voltage. In other words, it will take 2-3 min or longer for the quantity of light to reach a stable level. Also, although it is not shown in the figure, cooling is performed by a cooling fan or the like in order to avoid temperature rises caused by heating by the apparatus, especially, the light sources.

[0035]

Then, in said initial state, reflecting mirror 3 is provided at position 3 (A) that can reflect the light emitted from halogen lamp 2a to fly's-eye lens 5. Similarly, shutter 4 is provided at position 4 (C) for shielding the light beam from metal halide lamp 1a.

[0036]

In this case, reflecting mirror 3 is mechanically connected on the top edge (non-optical path part) of said mirror 3 to timing belt 19a with the aid of coupling member 19b. Shutter 4 is also mechanically connected on the top edge of shutter 4 (non-optical path part) at position (C) of timing belt 19a with the aid of coupling member 19c.

[0037]

The path of timing belt 19a is determined by four pulleys 20a, 20b, 20c, 20d as shown in Figure 1. Pulley 20d is mechanically engaged with gear 20e on the same shaft. Gear 20e is bigger than pulley 20d. Gear 20f is mechanically engaged at one spot on the outer periphery of gear 20e. Under the driving from electric motor 21, the rotation of pulley 20d is decelerated. Timing belt 19a obtains a sufficiently high torque so that timing belt 19a is conveyed.

[0038]

The positions where said mirror 3 and shutter 4 are stopped are determined by a detection means although it is not shown in the figure. A projection is formed partially on said mirror 3 and shutter 4, or a specific optical marking or projection is formed on timing belt 19a and is detected by a photointerrupter or detected mechanically by a microswitch. Alternatively, an electric conductor is formed as a projection in a part of said mirror 3 and shutter 4 or is directly formed on timing belt 19a, and the position is detected by electric conduction with the aid of a terminal. This can also be realized magnetically. In this application example, as shown in the block diagram of Figure 4, they are detected by detection switches 111, 112, which are connected to the two input ports of microcomputer 108. Under the programming processing of microcomputer 108, electric motor 21 is driven by motor driving circuit 109 to control the rotation and direction of said timing belt 19a to control the positions of said mirror 3 and shutter 4.

[0039]

Consequently, in the aforementioned initial state, the chromatic light from halogen lamp 2a is incident via mirror 3a on the first fly's-eye lens 5. The chromatic light passed through fly's-eye lens 5 is incident via mirror 6 on the second fly's-eye lens 7. The chromatic light incident on the second fly's-eye lens is also passed to dichroic mirror 8.

[0040]

Dichroic mirror 8 is arranged at a prescribed angle so that the passed light is set to the wavelength of blue color. The blue light is passed to reflecting mirror 10. The angle of its optical path is changed by reflecting mirror 10 to illuminate liquid crystal panel 17. On the other hand, dichroic mirror 8 reflects the green light and red light. With the optical path changed by 45° [sic] as shown in the figure, the green light and red light are incident on dichroic mirror 9.

[0041]

Dichroic mirror 9 reflects the green light to illuminate liquid crystal panel 16. Also, the red light is passed through dichroic mirror 9. The angle of its optical path is changed by reflecting mirrors 11 and 12 in the next stage to illuminate liquid crystal panel 15.

[0042]

Then, said liquid crystal panel 15 displays the red image by using the red signal processing circuit. Similarly, liquid crystal panel 16 displays the green image by using the green signal processing circuit. Liquid crystal panel 17 displays the blue image by using the blue signal processing circuit. The electric configuration is shown in the block diagram of Figure 4.

[0043]

In Figure 1, liquid crystal panels 15, 16, 17 used as the light panels are TFT active matrix liquid crystal panels made of transmissive polysilicon and having a size of about 0.9-1.8 inch, which have become the main stream in recent years.

[0044]

The images of blue light, green light, and red light output from said liquid crystal panels 15, 16, 17 are synthesized by cross dichroic prism 13 from their respective angles, and a magnified color image is projected on a screen by projection lens 14. The directions of the display images of said liquid crystal panels 15, 16, 17 are the same as those in the conventional example described in this specification.

[0045]

When said metal halide lamp 1a is close to a light emission state with an almost stable quantity of light after about 2-3 min during which the quantity of light gradually increases after the power is turned on in step S5 in Figure 5, it is found that the quantity of light emitted from metal halide lamp 1a is sufficient in step S6. When the quantity of light is judged to be sufficient, shutter 4 and mirror 3 are moved to the positions in the metal halide lamp mode in step S7. That is, said

electric motor 21 is driven to convey timing belt 19a in the direction indicated by arrow a via the pulleys 20f, 20e, 20d of the mechanical conveyance system. As a result, reflecting mirror 3 is moved to position (B).

[0046]

On the other hand, shutter 4 coupled with the same timing belt 19a is also moved along the same rotation direction to position (D). Although not shown in the figure, the position detecting sensors interact with said timing belt 19a or shutter 4, reflecting mirror 3, rotation mechanism 20 (20a-20f) as described above. Signals are fed back to microcomputer 108 shown in Figure 4. Under the programming processing of microcomputer 108, electric motor 21 is driven by motor driving circuit 109 to control the rotation and direction of said timing belt 19a to control the positions of said mirror 3 and shutter 4 and stop them at prescribed places. Then, it is determined in step S8 whether movement of shutter 4 and mirror 3 has been completed. Thus the light emitted from halide lamp 1a as a discharge tube is incident on fly's-eye lens 5 via reflecting mirror 3.

[0047]

The optical path after fly's-eye lens 5 is projected by projection lens 14 on a screen as explained above. Meanwhile, as the chromatic light from said halogen lamp 2 is shielded by shutter 4, the lamp is turned off soon after a safety period by light source control circuit 106 (step S9). After that, the projection is performed by using metal halide lamp 1a as the light source. The image can be display with stable and efficient projection with excellent color rendering properties.

[0048]

In Figure 5, the operation of stopping the apparatus is carried out in the order of stopping the switch control (step S10), stopping metal halide lamp 1a (step S11), stopping signal processing circuit 104 (step S12), returning shutter 4 and mirror 3 to the initial positions (step S13), turning off the cooling fan (step S14), stopping the standby lamp (step S15), and warming up microcomputer 108 (step S16).

[0049]

If a sudden power loss occurs in the stable and efficient projection state after the light source is switched from halogen lamp 2a to metal halide lamp 1a, as shown in the sequence diagram of Figure 6, the sudden power loss is detected in step S21. The power is turned on again in step S22. When the power is resumed, the cooling fan (not shown in the figure) is rotated to keep the internal temperature to a prescribed level, the power on/start control in step S1 and the initial microcomputer setting in step S2 are carried out in the same way as shown in Figure 5. Then, in

step S23, electric motor 21 is driven to convey timing belt 19a via the connection gear 20f, the large gear 20e, and pulley 20d in the power transmission system to return shutter 4 and reflecting mirror 3 to said positions (C), (A), respectively.

[0050]

Also, halogen lamp 2a is turned on instantaneously (step S3). The chromatic light of halogen lamp 2a is incident on fly's-eye lens 5, and the image is projected on the screen (step S4).

[0051]

Metal halide lamp 1a is turned on again. When it is found that the metal halide lamp is turned on again in step S24, lighting of metal halide lamp 1a is stopped during a relighting prohibition period determined by a timer in step S25. The relighting prohibition time determined by the timer in step S25 is based on compensating for the stability of the metal halide lamp. It is usually in the range from 2 to several minutes.

[0052]

Even if there is a sudden power loss, due to the aforementioned operation, the projection apparatus disclosed in this application example can resume projection immediately when the power supply is resumed without being limited by the relighting prohibition time of said metal halide lamp 1a.

[0053]

When the relighting prohibition period of metal halide lamp 1a has elapsed, said metal halide lamp 1a is turned on again (step S5), and it is checked whether the quantity of light emitted from metal halide lamp 1a reaches a prescribed level (step S6). When the prescribed quantity of light is reached, electric motor 21 is started in step S7 in the same sequence from lighting in the initial state described above to convey timing belt 19a via the connection gear 20f, large gear 20e, pulley 20d of the power transmission system to move shutter 4 to position (C) and move mirror 6 to position (D) [sic; mirror 3 to position (A)]. After it is confirmed that the movement has been completed in step S8, in step S9, the chromatic light from metal halide lamp 1a is used as the illuminating light to resume the highly-efficient projection with high color rendering property via fly's-eye lens 5.

[0054]

In the aforementioned application example, metal halide lamp 1a is used as the light source that takes time to reach the stable light state after it is turned on. In addition to the metal halide

lamp, it is also possible to use a high-pressure mercury lamp or a lamp in which a mercury-based gas is sealed.

[0055]

In addition to halogen lamp 2a, it is also possible to use a tungsten lamp or another incandescent lamp, a xenon discharge light-emitting tube in which xenon gas is sealed, a fluorescent lamp, a light-emitting diode, a fluorescent diode tube, or an electron-source-type light source as the light source that can provide a stable quantity of light immediately after it is turned on.

[0056]

It is also possible to omit shutter 4 and directly irradiate the chromatic light passing straight through without being reflected by mirror 3 to an optical light shielding case 18 or the like. In this case, optical light shielding case 18 can have a black surface so that light is difficult to reflect. It is also possible to take heat dissipation into consideration to protect against the temperature of optical light shielding case 18 rising as it is heated by the light.

[0057]

Additionally, instead of moving said mirror 4 to switch between two kinds of light sources, the same effect can be realized by fixing the optical path after said mirror 4 and moving said halogen lamp 2a and metal halide lamp 1a.

[0058]

As explained above, by adopting the configuration that uses halogen lamp 2a as the light source during the time waiting for the quantity of light emitted from the discharge tube, such as metal halide lamp 1a, to reach a stable level, it is possible to project the image immediately when the power of the main body is turned on or when the apparatus is started from the standby state.

[0059]

(Second application example)

In the first application example, the light source is switched by using a mirror and a shutter. In the projection apparatus disclosed in the second application example, as shown in Figures 8 and 4, metal halide lamp 1a as a discharge tube and halogen lamp 2a are disposed next to each other and are fixed near the focal point of reflecting mirror 1d having a common elliptical surface or paraboloid. Their electrodes 1c and 2c extend through said reflecting mirror 1d and are connected to lighting circuits 105 and 106 shown in the block diagram of Figure 4, respectively.

[0060]

The metal halide lamp 1a, halogen lamp 2a and their terminals installed in said common reflecting mirror 1d are called composite lamp unit 201 hereinafter. Figure 7 shows the appearance of composite lamp unit 201.

[0061]

Figure 8 shows the main parts of the projection apparatus disclosed in the second application example. In the following, the operation will be explained. In Figure 8, composite lamp unit 201 adopts such a configuration in which the light is incident on fly's-eye lens 5 via said reflecting mirror 3. The optical path after that is the same as that in the first application example.

[0062]

In the following, the operation of the projection apparatus disclosed in this application example after the power is turned on will be explained based on the sequence shown in Figure 9. First, immediately after the power is turned on or the operation switch is switched to the projection mode from the standby state in which the main power has been turned on in step S1, the microcomputer is initialized in step S2, and said halogen lamp 2a is turned on in step S3. Metal halide lamp 1a is also turned on.

[0063]

As far as the characteristics are concerned for the luminance rise of the two lamps immediately after they are turned on, as described above, halogen lamp 2a reaches a sufficiently high luminance immediately after it is turned on (usually about 300 mSec, which is about 90% of the final luminance) and achieves a stable light emission after that. Therefore, the signal processing circuit is started in step S4 to display the image.

[0064]

On the other hand, the quantity of light emitted from metal halide lamp 1a gradually increases as described above and reaches the final luminance value after about 2-3 min (step S5). If it is found that the quantity of light emitted from metal halide lamp 1a is sufficient in step S6, halogen lamp 2a is turned off in step S9. On the other hand, the quantity of light emitted from metal halide lamp 1a gradually increases as described above and reaches the final luminance value after about 2-3 min.

[0065]

Both of the chromatic light outputs are focused by reflecting mirror 1d and are incident on fly's-eye lens 5. After that, the image is projected in the same way as in the first application example. As the quantity of light emitted from metal halide lamp 1a is gradually increased, said halogen lamp lighting circuit 106 gradually reduces the quantity of light emitted from halogen lamp 2a over time to always keep the quantity of illuminating light constant.

[0066]

In the case of said halogen lamp lighting circuit 106, said microcomputer 108 shown in Figure 4 controls said halogen lamp lighting circuit 106 based on data for correcting the increase in the quantity of light of metal halide lamp 1a to gradually reduce the quantity of light of halogen lamp 2a. More specifically, the use of chopper control in halogen lamp lighting circuit 106 produces low power losses.

[0067]

The control of halogen lamp lighting circuit 106 by said microcomputer 108 can be digital signal parallel control or digital signal serial control or analog voltage control if microcomputer 108 has a D/A converter or a port for pulse width modulation (PWM) output. In this case, in halogen lamp lighting circuit 106, the control data sent from said microcomputer 108 are converted into, for example, pulse width values, and the chopper time is used to control the output voltage.

[0068]

For the stop processing flow shown in Figure 9, the stop operation is carried out in the order of stopping the switch control (step S10), stopping metal halide lamp 1a (step S11), stopping signal processing circuit 104 (step S12), stopping the cooling fan (step S14), and stopping the main power (step S17).

[0069]

(Third application example)

In the aforementioned second application example, as shown in Figure 8, a light quantity sensor is provided in the optical path to control said halogen lamp lighting circuit 106 with the aid of the microcomputer to keep the quantity of light constant. In this way, the quantity of light can be further stabilized.

[0070]

Light quantity sensor 200 is disposed at a position close to the bottom edge of the image area of liquid crystal panel 16 shown in Figure 8 to perform proper signal processing, such as integration, corresponding to noise or other external interferences, and can feed the processing result back to microcomputer 108. By using, for example, an integrated A/D converter, the microcomputer can quantify and digitize the signals to control said halogen lamp lighting circuit 106 depending on the sequence processing shown in Figure 10.

[0071]

In Figure 10, steps S1-S5 of the flow when the power is turned on are the same as those shown in Figure 9. After that, in step S31, the quantity of light is detected by the light quantity sensor. It is determined whether the detected quantity of light > specified value A in step S32. If it is true, the halogen lamp control voltage is lowered by one step in step S33. If it is found that the halogen lamp driving voltage < specified voltage B in step S34, the halogen lamp is turned off in step S9, and the operation is ended. The light quantity sensor used in this case can be a phototransistor, photodiode, solar cell, Cds sensor, or the like.

[0072]

Also, in this case, the light of the halogen lamp can be adjusted depending on the voltage. However, since the halogen lamp will deteriorate if the voltage drops below about 50% of the rated voltage, it is necessary to turn off the halogen lamp 2a for a driving voltage below that level.

[0073]

It is also necessary to consider the light adjustment range in other light sources described above whose luminance values increase rapidly after the light sources are turned on.

[0074]

Also, in the aforementioned first application example, the time from the point when the metal halide lamp is turned on can be counted by the microcomputer or other means. As opposed to switching said lamps as a function of the lighting time in the first application example, it is also possible to switch the lamps at a time when a specific luminance value is detected by the same light quantity sensor to further improve the accuracy. In this case, although said light quantity sensor is not shown in the figure, it is desired to dispose the sensor in part of the optical path of the metal halide lamp.

[0075]

(Fourth application example)

In the aforementioned first, second, and third application examples, a metal halide lamp 1a as a discharge tube acting as the first light source and a halogen lamp 2a acting as the second light source are switched. In particular, halogen lamp 2a usually has a lower color temperature than said metal halide lamp 1a.

[0076]

Consequently, in this application example, a trimming filter can be inserted between halogen lamp 2a and the optical path switching means to improve the color temperature so that variation in color temperature can be reduced.

[0077]

(Fifth application example)

Instead of improving the color temperature optically as described above, it is also possible to reduce the variation in color temperature by a means, which interacts with the light source switching means to change the balance between the level, setup (brightness), and degamma correction of the three red, blue, and green signals of the signal processing circuit.

[0078]

In signal processing circuit 104 shown in the circuit block diagram of Figure 4, the balance between the level, setup (brightness), and degamma correction values of the three red, blue, and green signals of signal processing circuit 104 is controlled by microcomputer 108 (not shown in the figure) based on color temperature switching signals interacting with the light source switching control. This configuration avoids extreme variation in the color temperature when the aforementioned light sources are switched.

[0079]

The projection apparatuses disclosed in the aforementioned application examples use two light sources to realize instantaneous projection. Practical, bright images can be projected immediately after the power is turned on. Also, projected images with very good color rendering properties can be obtained efficiently as the quantity of light is increased step by step. In addition, it is possible to resume the projection state immediately even if there is a sudden power loss.

Effect of the invention

The present invention can realize a suitable projection apparatus using a plurality of light sources.

Brief description of figures

Figure 1 is a schematic illustrating the optical layout of the projector in the liquid crystal projection apparatus disclosed in the first application example of the present invention.

Figure 2 is the structural diagram of the metal halide lamp unit in the application example of the present invention.

Figure 3 is the structural diagram of the halogen lamp unit in the application example of the present invention.

Figure 4 is the circuit block diagram of the application example of the present invention.

Figure 5 is the lamp lighting control flow chart in the first application example of the present invention.

Figure 6 is a flow chart illustrating the lamp relighting processing control in the first application example of the present invention.

Figure 7 shows the structure of the composite lamp unit in the first application example of the present invention. Figure 7(A) is a side view, and Figure 7(B) is the front view.

Figure 8 is a schematic illustrating the optical layout of the projector in the liquid crystal projection apparatus disclosed in the second application example of the present invention.

Figure 9 is a flow chart explaining the operation of the projection apparatuses disclosed in the second and third application examples of the present invention.

Figure 10 is a flow chart explaining the operation of the projection apparatuses disclosed in the second and third application examples of the present invention.

Figure 11 is a configuration diagram illustrating an example of the conventional projection apparatus.

Explanation of symbols

1a	Metal halide lamp as a discharge tube
1b	Reflecting mirror formed into an elliptical surface or paraboloid
1c	Electrode of metal halide lamp 1a
1d	Reflecting mirror
2a	Halogen lamp
2b	Reflecting mirror formed into an elliptical surface or paraboloid
2c	Electrode of halogen lamp 2a
3	Movable mirror

4	Shutter
5	First fly's-eye lens
6	Reflecting mirror
7	Second fly's-eye lens
8, 9	Dichroic mirror
10, 11, 12	Mirror
13	Cross dichroic prism
14	Projection lens
15	Red transmissive liquid crystal panel
16	Green transmissive liquid crystal panel
17	Blue transmissive liquid crystal panel
18	Optical light shielding case
19a	Timing belt
19b	Coupling member that couples the timing belt with movable mirror 3
19c	Coupling member that couples the timing belt with shutter 4
20a, 20b, 20c	Pulleys for conveying the timing belt
20d	Pulley for conveying the gear-interacting timing belt
20e	Gear that is engaged with pulley 20d and has a bigger diameter than pulley 20d
20f	Gear engaged with said gear 20e
21	Electric motor engaged coaxially with said gear 20f
100	Housing accommodating the entire projection system
101	Red signal input terminal
102	Green signal input terminal
103	Blue signal input terminal
104	Signal processing circuit block
105	Metal halide lamp lighting circuit
106	Halogen lamp lighting circuit
107	Main power supply circuit
108	Microcomputer controlling the main system
109	Motor driving circuit that drives the timing belt
110	Power supply terminal of this apparatus
111, 112	Switch used as sensor for detecting the position of the timing belt or shutter
200	Light quantity sensor

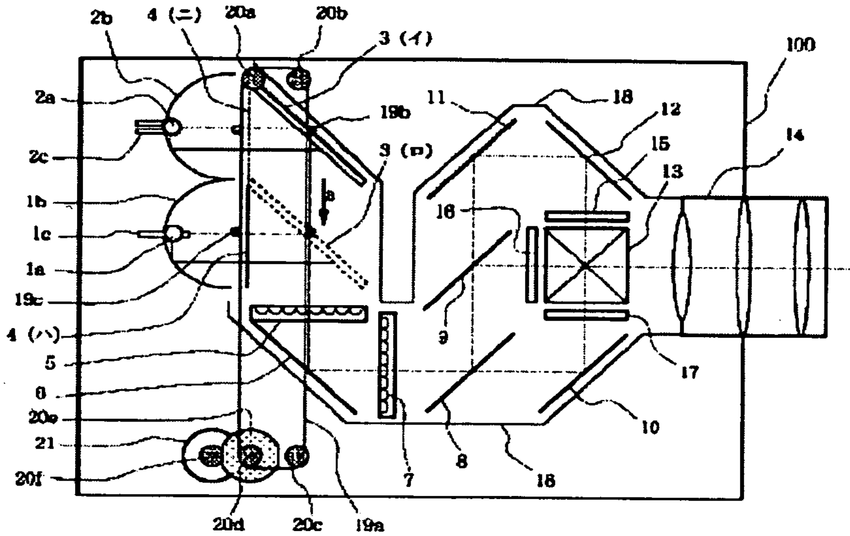


Figure 1

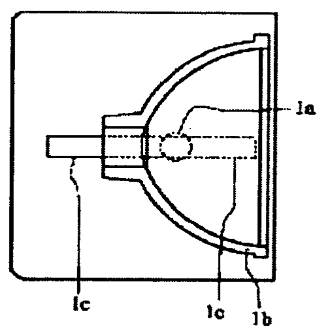


Figure 2

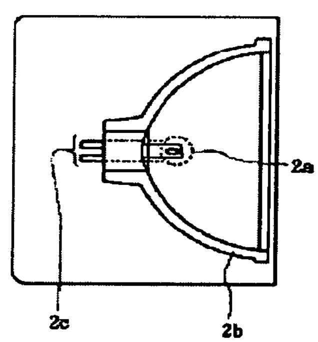


Figure 3

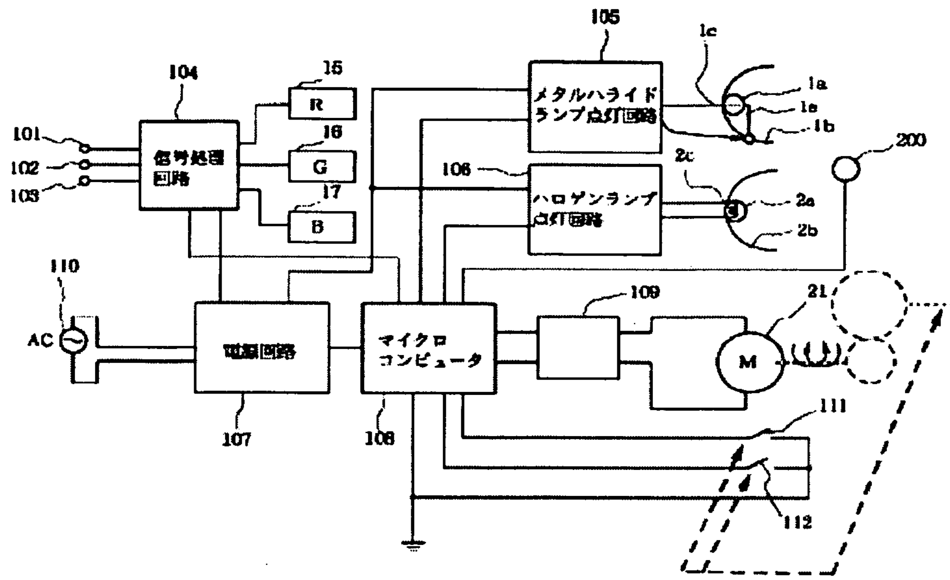


Figure 4

Key:
- 104 Signal processing circuit
- 105 Metal halide lamp lighting circuit
- 106 Halogen lamp lighting circuit
- 107 Power supply circuit
- 108 Microcomputer

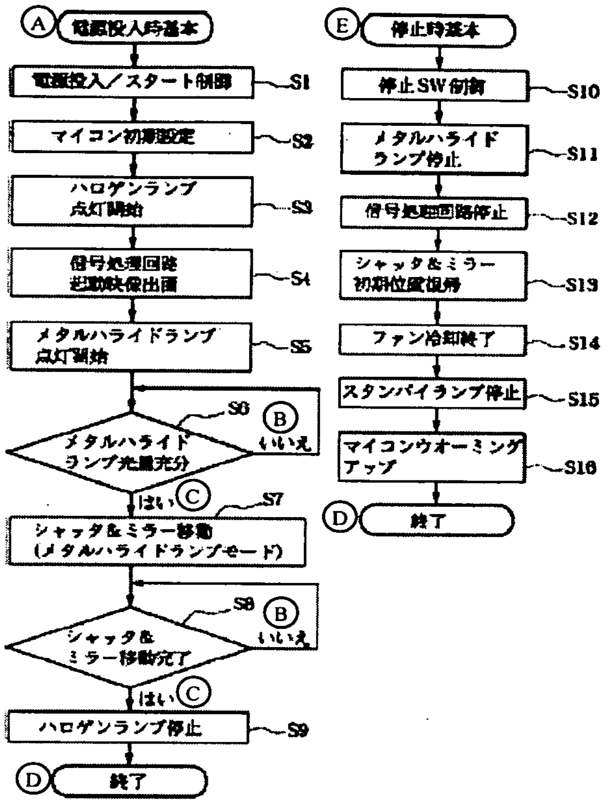


Figure 5

Key:

Key:	A	Basic process for turning on the power
	B	No
	C	Yes
	D	End
	E	Basic process for stopping
	S1	Power on/start control
	S2	Initialize the microcomputer
	S3	Start lighting of the halogen lamp
	S4	Start the signal processing circuit to display image
	S5	Start lighting of the metal halide lamp
	S6	Is the quantity of light emitted from the metal halide lamp sufficient?
	S7	Move the shutter and mirror (metal halide lamp mode)
	S8	Has the movement of the shutter and mirror been completed?
	S9	Turn off the halogen lamp
	S10	Stop SW control
	S11	Stop the metal halide lamp
	S12	Stop the signal processing circuit
	S13	Return the mirror and the shutter to the initial positions
	S14	Stop the cooling fan
	S15	Stop the standby lamp
	S16	Warm up the microcomputer

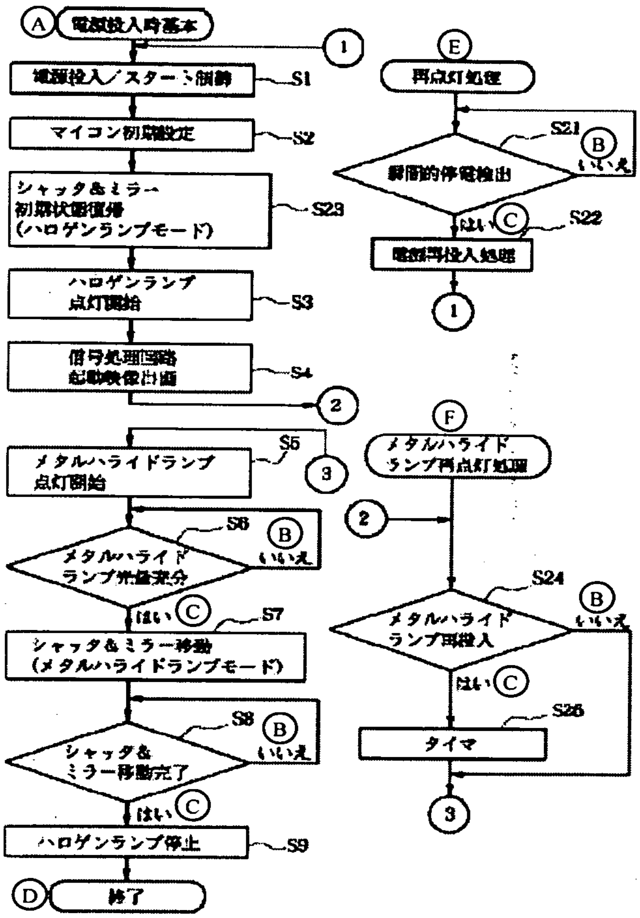


Figure 6

Key:

A	Basic process for turning on the power
B	No
C	Yes
D	End
E	Relighting processing
F	Relighting of the metal halide lamp
S1	Power on/start control
S2	Initialize the microcomputer
S3	Start lighting of the halogen lamp
S4	Start the signal processing circuit to display image
S5	Start lighting of the metal halide lamp
S6	Is the quantity of light emitted from the metal halide lamp sufficient?
S7	Move the shutter and mirror (metal halide lamp mode)
S8	Has the movement of the shutter and mirror been completed?
S9	Turn off the halogen lamp
S21	Instantaneous power outage detected?

S22 Turn on the power again
S23 Resume the initial states of the shutter and mirror (halogen lamp mode)
S24 Is the metal halide lamp turned on again?
S25 Timer

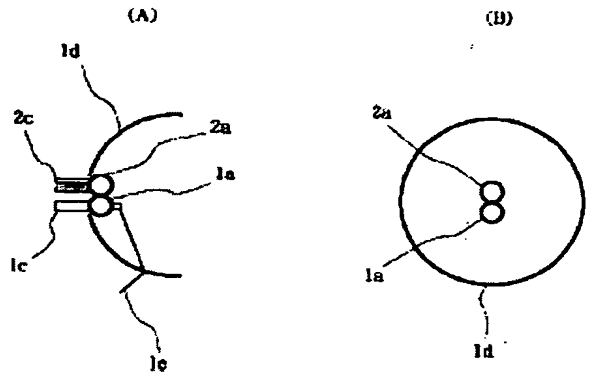


Figure 7

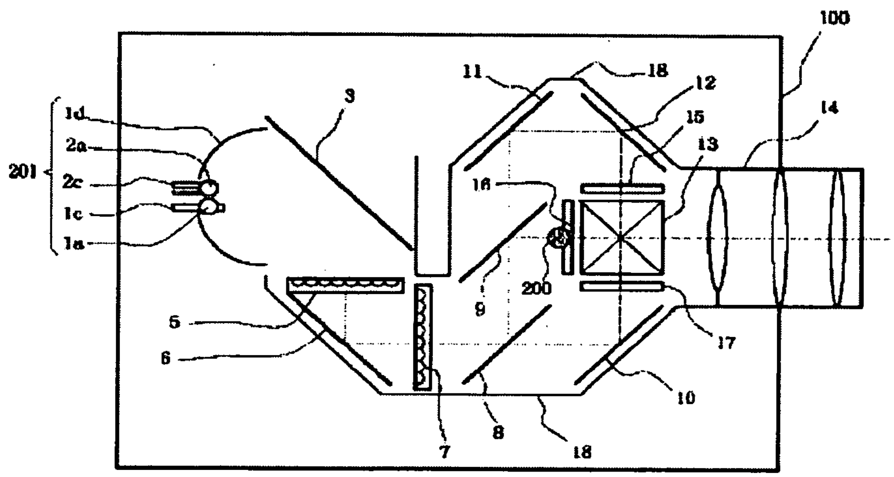


Figure 8

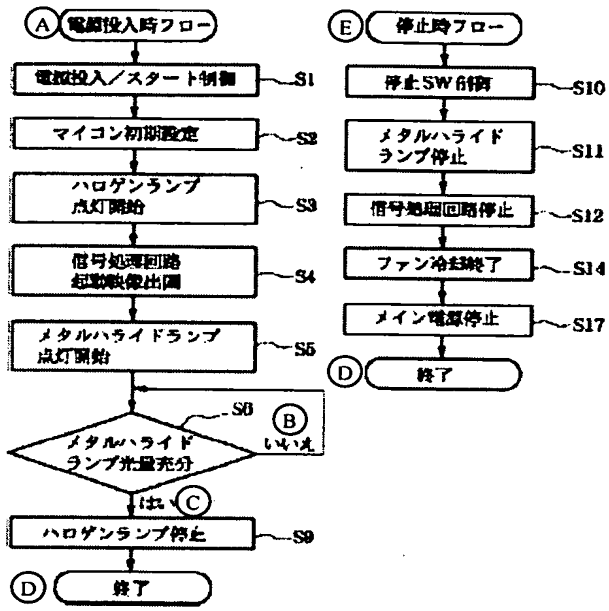


Figure 9

Key:	A	Flow for turning on the power
	B	No
	C	Yes
	D	End
	E	Flow for stopping the apparatus
	S1	Power on/start control
	S2	Initialize the microcomputer
	S3	Start lighting of the halogen lamp
	S4	Start the signal processing circuit to display image
	S5	Start lighting of the metal halide lamp
	S6	Is the quantity of light emitted from the metal halide lamp sufficient?
	S9	Turn off the halogen lamp
	S10	Stop SW control
	S11	Stop the metal halide lamp
	S12	Stop the signal processing circuit
	S14	Stop the cooling fan
	S17	Stop the main power

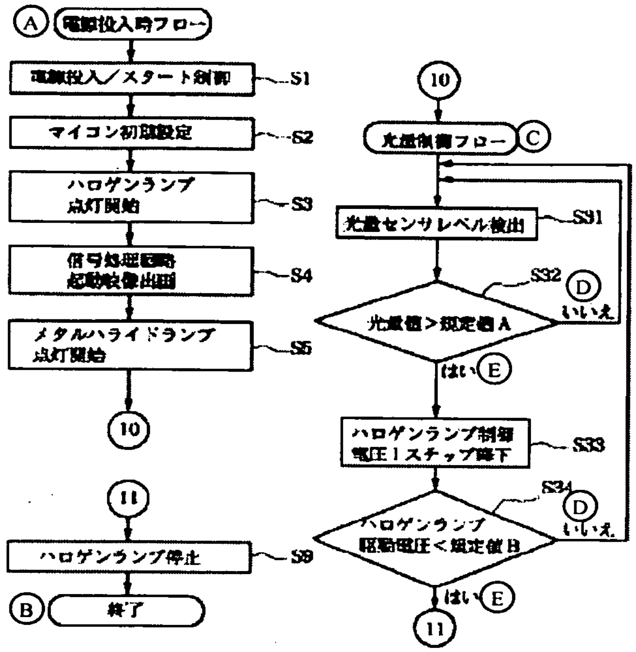


Figure 10

Key:

	A	Flow for turning on the power
	B	End
	C	Flow for controlling the quantity of light
	D	No
	E	Yes
	S1	Power on/start control
	S2	Initialize the microcomputer
	S3	Start lighting of the halogen lamp
	S4	Start the signal processing circuit to display image
	S5	Start lighting of the metal halide lamp
	S9	Turn off the halogen lamp
	S31	The light quantity sensor detects the quantity of light
	S32	Detected quantity of light > specified value A
	S33	Lower the control voltage of the halogen lamp by one step
	S34	Driving voltage of the halogen lamp < specified value B

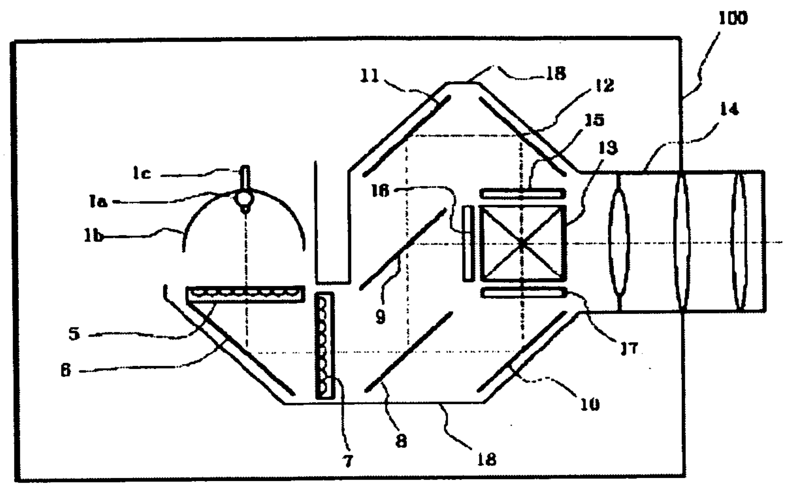


Figure 11

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